ON DIFFERENTIAL MORTALITY WITH RESPECT TO SEED WEIGHT OCCURRING IN FIELD CULTURES OF PISUM SATIVUM

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In two papers which have already appeared in these pages,[1] I have shown that for the dwarf varieties of *Phaseolus vulgaris* the mortality of apparently perfect seeds (failure to germinate or to complete the life cycle) is not random, but differential, or selective.

It seemed highly desirable to extend these studies to other forms. *Pisum sativum* naturally occurred to me as affording suitable experimental material—both because of the wide range of seed characteristics and the convenience with which it may be bred. I had no pedigreed seed and consequently began work in the spring of 1913 with commercial stock. About 1,000 seeds from each of ten early (dwarf) varieties purchased from the Thorburn seed company were weighed, individually labelled and planted in short rows scattered over one of the fields of the Station for Experimental Evolution. Conditions were not the best, and the mortality was high.

Table I[2] gives the weights in units of .025 gram range[3]

[1] Harris, J. Arthur, "On Differential Mortality with Respect to Seed Weight Occurring in Field Cultures of *Phaseolus vulgaris*," Amer. Nat., 46: 512–525, 1912; "Supplementary Studies on the Differential Mortality with Respect to Seed Weight in the Germination of Garden Beans," Amer. Nat. [in press].

[2] For convenience the series may be designated by letters: *A*, Witham Wonder; *B*, American Wonder; *C*, Premium Gem; *D*, Little Gem; *E*, Nott's Excelsior; *F*, Sutton's Excelsior; *G*, Laxtonian; *H*, Little Marvel; *I*, Peter Pan; *J*, English Wonder.

[3] Class 1 = 0.000–.025 gram, . . . class 4 = .075–.100, class 5 = .100–.125, and so on. Thus to obtain means or standard deviations of weights in grams, deduct .5 from the values in the tables and multiply by .025.

TABLE I

WEIGHT OF SEEDS WHICH GERMINATED

Series	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Totals
A	1	6	31	64	65	100	75	57	42	19	6	1	1	—	—	—	—	468
B	—	—	—	—	40	107	134	170	105	35	12	1	—	—	—	—	—	604
C	—	—	3	5	53	117	173	126	56	11	3	2	—	—	—	—	—	549
D	—	—	—	3	36	106	191	167	80	18	4	1	—	—	—	—	—	606
E	—	—	—	5	49	105	105	68	32	3	—	—	—	—	—	—	—	367
F	—	—	—	—	9	27	63	96	86	69	26	11	4	—	—	—	—	391
G	—	—	—	—	1	7	27	71	114	159	132	81	23	16	—	—	—	631
H	—	—	—	1	17	44	116	183	151	63	20	6	2	—	—	—	—	603
I	—	2	—	2	6	8	16	25	51	88	127	126	101	55	17	8	1	633
J	—	—	—	17	107	126	142	112	41	13	5	2	—	—	—	—	—	565

TABLE II

WEIGHT OF SEEDS WHICH FAILED TO GERMINATE

Series	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Totals
A	4	16	49	63	102	90	93	78	42	16	2	1	—	—	—	—	—	556
B	—	—	—	2	—	52	104	117	84	36	3	—	2	—	—	—	—	400
C	—	2	1	12	56	116	122	95	34	18	4	1	—	—	—	—	—	461
D	—	—	1	5	37	88	127	93	37	11	—	—	—	—	—	—	—	399
E	—	—	—	13	115	210	180	91	23	4	1	—	—	—	—	—	—	637
F	—	—	—	—	13	46	84	125	153	114	49	16	10	3	—	—	—	613
G	—	—	—	—	5	6	29	43	75	85	70	42	13	7	—	—	1	376
H	—	—	—	1	17	66	71	110	93	29	14	3	—	—	—	—	—	404
I	—	—	3	1	13	18	26	35	29	60	65	62	31	22	3	2	4	374
J	—	—	—	13	55	88	125	91	53	12	2	—	—	—	—	—	—	439

of the seeds which germinated.[4] Table II gives the same distributions for the seeds which failed to germinate. The physical constants[5] with their probable errors are given in Tables III–IV.

Taking the differences, germinated *less* failed, in order to have the positive sign if elimination tends to increase mean weight or variability of weight and the negative sign if it tends to decrease these constants in the population of seeds which grow as compared with those which fail, I find the differences shown in Table V.

[4] When the plantlets were about three inches high the labels for seeds which had failed to germinate were collected. The distributions for the seeds which had germinated were then obtained by subtraction from the weight seriations prepared before planting. Some of the plants subsequently died.

[5] Sheppard's correction was applied to the second moments.

TABLE III

Physical Constants for Seeds which Germinated

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
A	9.254 ± .062	2.000 ± .044	21.610 ± .498
B	10.581 ± .038	1.371 ± .027	12.954 ± .256
C	10.078 ± .037	1.294 ± .026	12.844 ± .266
D	10.355 ± .033	1.211 ± .023	11.692 ± .230
E	9.790 ± .042	1.193 ± .030	12.185 ± .308
F	11.568 ± .054	1.571 ± .038	13.583 ± .334
G	13.090 ± .043	1.612 ± .031	12.313 ± .237
H	11.186 ± .037	1.362 ± .026	12.178 ± .240
I	14.269 ± .057	2.134 ± .041	14.958 ± .290
J	9.773 ± .040	1.429 ± .029	14.622 ± .300

TABLE IV

Physical Constants for Seeds which Failed to Germinate

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
A	8.993 ± .057	2.003 ± .041	22.286 ± .472
B	10.898 ± .041	1.236 ± .030	11.346 ± .274
C	9.913 ± .045	1.439 ± .032	14.512 ± .329
D	10.048 ± .041	1.229 ± .029	12.234 ± .296
E	9.488 ± .030	1.122 ± .021	11.826 ± .227
F	11.726 ± .045	1.653 ± .032	14.097 ± .277
G	12.816 ± .062	1.787 ± .044	13.945 ± .350
H	10.869 ± .049	1.447 ± .034	13.317 ± .322
I	13.225 ± .089	2.552 ± .063	19.298 ± .493
J	10.009 ± .044	1.376 ± .031	13.749 ± .311

TABLE V

Comparison of Physical Constants for Seeds Germinating with those for Seeds Failing to Germinate

Series	Difference in Mean and Probable Error of Difference	Difference in Standard Deviation and Probable Error of Difference	Difference in Coefficient of Variation and Probable Error of Difference
A	+ .261 ± .085	−.003 ± .060	−1.676 ± .686
B	− .316 ± .057	+.134 ± .040	+1.608 ± .375
C	+ .165 ± .058	−.144 ± .041	−1.669 ± .423
D	+ .307 ± .053	−.019 ± .037	− .542 ± .375
E	+ .302 ± .051	+.071 ± .036	+ .358 ± .382
F	− .158 ± .070	−.082 ± .049	− .513 ± .434
G	+ .274 ± .075	−.175 ± .054	−1.632 ± .422
H	+ .317 ± .062	−.085 ± .044	−1.139 ± .401
I	+1.044 ± .105	−.418 ± .074	−4.340 ± .572
J	− .236 ± .060	+.053 ± .042	+ .873 ± .432

Consider first the differences in the mean weight. Seven are positive and three are negative. All of the

seven positive differences are at least 2.5 times their probable error; four of them are over five times their probable error. The mortality is therefore almost certainly selective, with a tendency to leave the surviving population with seeds distinctly heavier on the average than those which were planted. On the other hand, there are the three cases in which the seeds which produced plantlets were on the average lighter than those which failed to germinate. One of these differences is only 2.2 times its probable error, and so perhaps not statistically trustworthy. Of the other two, one is over 5.5 times and the other nearly 4 times its probable error. There can be little doubt that in at least one of these cases there is a tendency for the lighter seeds to show a viability greater than that of the heavier. In garden beans, too, strong evidences of differences between strains in this regard have been pointed out.

The interpretation of the variabilities offers greater difficulties than does that of the means. More data and more refined methods of analysis are necessary for a final solution of the problem. It appears, however, that in seven of the ten series the variability of the seeds which survived is less than that of those which failed. This is true whether absolute variability as measured by the standard deviation or relative variability as expressed by the coefficient of variation be used in the comparison.

As far as these data go, therefore, they are in general accord with those for *Phaseolus*. In both of these Leguminosæ the mortality which occurs before germination is not random but differential. But in both cases, and especially in *Pisum* where the seeds used are of commercial, not pedigreed, stock and number as yet only about 10,000, far wider series of experiments and much refinement of methods of analysis are necessary to establish fully the nature and the immediate (physical or chemical) cause of this selective death rate.

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